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BIOCHEMICAL EFFECTS OF STATIC ELECTRICITY DURING GORDON'S EVA

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BIOCHEMICAL EFFECTS OF STATIC ELECTRICITY DURING GORDON'S EVA

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The author reports his experiences with static electricity in his practice and details his theory attributing Gordon's enervation in his space walk to accumulated frictional static electricity. This electricity can impede cell respiration and produce a neuroallergic shock effect due to damaged cells.

Why did Mr. Gordon, Astronaut of the American Spacecraft Gemini 11, Become Weak and Unable to Work in the Course of His Space Walk?

From newspaper and radio reports I received the information that astronaut /1* Gordon, in spite of magnificent physical condition and health, became unable to work after a short time during his space walk because of a strong feeling of physical weakness, so that he had to return to his ship without having fulfilled the tasks that had been planned.

Mr. Director: With my modest opinion, communicated in this letter, I should like to seek the true cause of the Honorable Mr. Gordon's physical weakness during his space walk. Before I communicate my theory I should like to make a few remarks about the effect of static electricity encountered in my medical practice.

The floor in my work room is covered with Gummolite, a synthetic material, which, as is well known, has an ideal electrical insulating capacity. The insulation of the human being from the Earth can be raised to a higher power by complete drying out of the air by central heating and by synthetic materials, the wearing of rubber-soled shoes, etc. One day my assistant called to my attention the fact that she always felt an unpleasantly strong electric shock in the hands when her fingers came close enough to the metal furniture in my operating room to form a spark gap. Every time she got up from a chair, audible electric sparks /2 jumped from her skirt toward the laquered wooden seat of the iron-frame chair. She only had to make a few rubbing motions on this chair to cause the phenomenon. At first I thought that the high-voltage bioelectricity in my colleague arose from mental excitation, but after I and other colleagues and also patients saw, felt and heard the same electric phenomena, I started to seek the true reason for this electric effect. After consultation with several specialists, physicists, I can now prove definitively that these phenomena are triggered by frictional electricity that arises in every human after rubbing on the laquered surface of chairs. The possibility of electric discharge ceased when the humidity in the air of our work room became normal and conductive after a failure of the central heating.

After these personal experiences I should like to give the answer to the question asked above. First I shall consider the possibility of the production of static electricity in Gordon's body, and then I shall address myself to the description of the effect of this high-voltage electricity on the human being.

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* Numbers given in the margin indicate the pages of the original foreign text.

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How Could Static Electricity be Produced in Gordon's Body in the Course of His Space Walk?

The frictional electricity could also have originated in Gordon while he was in the rocket, his space suit, made of synthetic material, making the production /3 of this frictional electricity possible. Thus, the high voltage static electricity did not remain in Gordon's body: it was conducted away by normal humidity in the pilot's cabin into the mighty metallic body of the rocket. It could not cause major pathobiological or pathochemical changes in the organism of the pilot. With an induction effection or through induction and leakage this high voltage could, however, cause a short circuit in the storage batteries, as happened in the Gemini 8 rocket, or it could damage the fine structure of the various electric instruments by induction.

But a different situation arose when Gordon stepped out into airless space. At every movement, high-voltage static electricity was generated in his body. Conducting this high voltage away is impossible in space. There is no humid air there, and the astronauts are ideally insulated from their rocket during the space walk. The possibility of conducting the high voltage away from the body of the astronaut by means of the so-called "umbilical cord" is also made difficult, because in the same way as in the clouds, enormously high voltages can also arise in the rocket in view of the circumstance that the rocket, flying at fantastic speed in the Earth's magnetic field, permits generation of the high voltages. Conduction, via the umbilical cord, of the high-voltage electricity generated in the astronaut's body would be possible only if the voltage that is generated in the rocket is lower than that in the astronaut's body. This is not so. The /4 electricity in the rocket is always higher. We must not forget that the astronauts, charged with frictional electricity, are also moving with tremendous speed in the Earth's magnetic field and their charge increases. The increase in the electrical potential follows the law of induction discovered by Faraday in 1832. If the amount of magnetic flux that passes through a conductor loop changes, there will be generated a voltage E between the ends of the loop:

$$E = \frac{d\Phi}{dt} . n . 10^{-8} [V]$$

where $\frac{d\Phi}{dt}$ is the change per unit time of the number of induction lines that pass through the conductor loop and [n is] the number of turns in the wire loop; 10^{-8} is the factor for converting from electromagnetic to practical units. In our case the electric potential of the astronaut flying in space depends on the number of electromagnetic lines of the Earth's magnetic field that have been intersected and of the number and speed of the circuits around the Earth. We must also reckon with a heating effect being generated by induction in the space suit, which can raise the temperature inside the space suit unpleasantly.

What Biochemical Changes can Occur in the Organism of the Astronaut Who is Charged With High-Voltage Static Electricity?

The high-voltage static electricity can cause various biochemical changes in the organism of humans and experimental animals: 1- a direct effect harmful to cell respiration and 2- a neuroallergic shock effect which is provoked by the autoaggressive peptide-and nucleoprotein-antigen fragments and polyantigens

released by the damaged cells. The start of the cell-respiration-damaging effect of the static electricity depends not only on the duration of the exposure but also on the pH of the cells. A low pH value in the cells always increases the possibility of dissociation of the molecules and electron ejection from water molecules and also from other molecules. In the destruction of the cell respiration control, the most important parts are played by the H, H_2, OH and OH_2 /5

ions released from the said molecules, and also the H_2O_2 molecules generated by

the effect of the high voltage. These free ions and the peroxide and molecules, which are strong oxidizing agents, have a significant pathological importance for the changes in the system controlling cell respiration. Through the oxidizing effect enzymes containing SH groups are inactivated and their function is inhibited. The physiological condition of oxidized and reduced glutathione plays an important part in the control of the redox system. After exposure to high voltage, the oxidized glutathione molecules are increased. The individual links in the cell respiration chain are also oxidized by the above mentioned ions, so the proportions of the $NADH_2$/NAD, $FADH_2$/FAD, oxidized,cytochrome,Fe/reduced,

cytochrome, Fe, oxidized, cytochrome oxidase/reduced cytochrome oxidase also are changed. After the functional inhibition of glycolysis and the respiration chain in the cells the possibility of ATP synthesis by oxidative phosphorylation is also compromised. A deficit in ATP synthesis has severe pathobiochemical consequences not only in the damaged cells, but also in the entire organism. ATP has very important central biological functions in the regulation of metabolic reactions. These are the most important:

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1. Energy transfer through respiration;
2. Energy and phosphate transfer through glycolysis;
3. Activation of amino acids and nucleotides for protein and nucleic acid synthesis;
4. Activation of fatty acids for their break-down;
5. Formation of active sulfate;
6. Formation of active methyl.

Of the biological functions, the most important role of ATP is the regulation of muscular contraction. ATP and phosphocreatine can be regenerated by glycolysis through the breakdown of the glycogen reserves. However, in cells damaged by exposure to high voltage glycolysis and oxidative phosphorylation connected with the respiration chain are also inhibited. After the oxidative breakdown of the glucose molecules, amino acids and lipids, there occurs in the cells a substrate deficit for physiological glycolysis and connected with it for the ATP forming and consuming processes. It is possible that the improvement of malignant granulations, neoplasms, after exposure to electromagnetic high voltage in animal experiments by several researchers were also achieved by inhibition of in the synthesis of ATP and other high-energy, so-called, macroergic phosphate compounds. It is certain that RNA, and DNA synthesis is only possible with formation of the various nucleotide phosphate anhydrides, dATP, dGTP, dCTP, dTTP. These nucleotide phosphate anhydrides which deliver the immediate building blocks for the desoxyribonucleic acid, the key to the specific genetically conditioned code for protein synthesis, can only be synthesized with the cooperation of the ATP molecules.

The muscular weakness occurring in astronaut Gordon was therefore a consequence of the disturbance of the ATP forming and consuming processes that are necessary for normal muscular activity. The high-voltage static electricity can influence the biological discharge of the neurovegetative control. In the nerves /7
of a human being charged with high-voltage static electricity an electric current, generated according to Faraday's law, can impart an abnormal bioelectric rhythm to the biological processes. This changed bioelectric rhythm acts like physical stress effects which after mobilization of the most varied vasomotor substances and catecholamines potentiates the cell damage with their anoxemizing effect. In the anoxemic cells, histamine and other H substances will be released which with the metallic molecules of the cytochromes make possible the formation of so-called histamine-hemin complexes with strong catalase and peroxidase effects possible. The damage to cell respiration is therefore caused not only by substrate deficit in the glycolytic processes and the oxidative phosphorylation but also by massive histamine release from the damaged cells.

In the cells which are damaged by high voltage, the various organic acids and aldehydes increase and cause an unphysiological distribution of anions and cations. Potassium flows out of the anoxemic cells and sodium enters. The calcium content of the blood plasma is lowered, postacidetic conditions following stress. After the impoverishment of the free Ca ions the activity of the factors of muscle contraction and relaxation control is changed. The activity of the enzymes, histaminase and cholinesterase is impeded. A hypervagotonic condition begins in the organism. A bradycardia is accompanied by hypotonia. The cause of this hemodynamic change is the liberation of the toxic vasodilators histamine and H substances as well as a relative hyperkalemia. To these hemodynamic phenomena
are also joined the neuroallergic reactions provoked by the autoaggressive sub- /8
stances, auto-semi antigens in the organism that were damaged by high voltages. How do these autoagressive antigens originate? After the destruction of the mitochondria the most varied hydrolyzing enzymes are released from the lysosomes, namely DNAse, RNAse, phosphomonoesterase, phosphoprotein phosphatase, β-glucronidase , βN-glucosamidase, β-galactosidase, α mannosidase, proteases, arylsulfatases. After the release of these hydrolyzing enzymes the structural breakdown of the cells begins. By an autocatalytic process the most varied peptides, nucleoproteins, mucoprotein and lipoprotein fragments, all macromolecules having antigenic properties can be produced. The cells of the individual organs can be sensitized by these macromolecules, resulting in the occurrence of the most varied neuroallergic response reactions. Inflammations with or without bacterial superinfection, chronic degenerative changes, but also malign granulation, neoplasms or sarcomas. An accelerated hazard of embolism in the astronaut who has been injured by the high voltage effect is also possible and for that reason I shall discuss that problem. Following the various stresses in the finest capillaries of the arteries and in the vasa-vasorum of the veins a constriction/ capillary spasm begins. After the constriction of these vascular capillaries a hypoxemia occurs in the cells of the adventitia and media of the larger arteries and veins. In these anoxemic cells a destruction of the cell structure begins, and starts a reactive defensive inflammatory process. This inflammation in the adventitia and media of the larger arteries and veins can remain in loco and heal with discrete scar formation usque ad integrum, but phlebectasias and arterial aneurisms can also develop from them. It can also happen /9
that the inflammatory shock response reactions of the adventitia and media do not remain in loco, but spread in continuity to the intima of the vessels there

promoting thrombosis after having damaged the epithelial cells. In the cells of the intima where these islands of damage, (micronecroses) occur, the fragmentation of the microstructure of the cells begins, with subsequent respiration damage and with the liberation of the most varied bio - and vasoactive substances. After respiration damage various resins can develop in the wounds of trees. In the cells of the intima, in which the glycolysis and the respiration are inhibited, the possibility of formation of various polymers of the polysaccharide acids and aldehydes is obvious. The lungs fill with sputum-phlegmlike polymers. These high-molecular complexes have an antigenic quality and with their strong adhesiveness they can, together with the peptide molecules, supply the macroagglomerate of the nucleus of a thrombus. But the development of thrombosis three factors are required--damage to the structure of the intima cells, a slowed down circulation in the vessels of the damaged region and an increased coagulalability of the blood. These resin-like macromolecules can also be the substrates for many adaptive polymerases which then make possible the formation of the mucin-hyalin, amyloid or other pseudo-rubber complexes which accelerate the degenerative processes of the vessels. The development of sclerotic plaques is in my opinion invariably the result of repeated microshock traumatizations of the intima cells. The nature of this traumatizing can be local and mechanical, but it can also be a generalized stress of chemotoxic, physical or neuroallergic nature. The increase of the mucoprotein and lipoprotein polymers and other products of degeneration mentioned, which have developed after repeated inflammation, depends on several factors. /10 In an organism in which for any reason whatever the utilization of sugar is impeded, the development of the degenerative processes in the intima cells of the vessels will be accelerated. The utilization of sugar is impaired in a traumatized organism, and it is therefore better if the astronauts during the duration of their space navigation consume a diet low in sugar and fat with various raw fruit juices. Vitamin B^2, vitamin P and vitamin E and of course C play an important role in the defensive reaction.

In addition to the pathological phenomena mentioned still other neuroallergic, neuroshock reactions can occur in the astronauts. In cells sensitized by autoantigen action, allergic inflammations can be provoked by any antigen-antibody reaction. It is not known which group of the individual organs in an organism is sensitized. Neuroallergic response reactions can occur in every organ. The magnitude and duration of the damage depends on the immunobiochemical condition of the sensitized cells and of the condition of the neurovegetative and neurohormonal mechanism controlling the defense reactions. From clavus and dental caries to the development of lung emboli, the most varied neuroallergic reactions can occur in the organism of the astronaut when the individual organs in the course of their lives become sensitized. In my opinion also malignant granulations are a form of neuroallergic response reaction which always occurs in humans who have been traumatized often and severely, with various stresses. During prolonged space flights we must count on the possibility of the development of allergic reactions in the tonsils, respiratory tract, lungs, stomach, intestinal tract, with inflammatory allergic reactions in the reproductive and /11 urinary organs as well as of the peripheral and central nervous system, the organs of circulation, and also with regulatory disturbances of the endocrine system changed by allergic reaction, inflammation, degeneration or granulations. An allergic appendicitis also can occur as can neuroallergic neuralgia in various parts of the body. In addition to the damage to the central nervous system,

we can count on the development of a coronary infarct or embolism in various vessels in the astronauts who have been sensitized by various physical and mental stresses.

In order to avoid the possibility of the catastrophic collision of the rocket and the human, in the course of the docking maneuver of two rockets, there should be a counteraction to the mechanical forces which according to Coulomb's law act between two electric charges, rocket and man. This law is as follows: Two charges, Q_1 and Q_2, exert a force on each other which is directly proportional to the product of the two charges and inversely proportional to the square of their distance from each other

$$K=k\frac{Q_1 \quad Q_2}{r^2}$$

In the lawfully prescribed international system of units the Coulomb C or amp second As is used as unit for the quantity of electricity. Thus the proportionality factor becomes

$$K=\frac{1}{4\pi\epsilon_o}$$

ϵ_o is $8.85\cdot10^{-12}$ As/Vm, the electrostatic constant or absolute dielectric constant of vacuum.

Taking the complications of space travel described above into consideration, /12 it is necessary on prolonged flight that there be a physician-astronaut present in the rocket, a person with the best surgical erudition who also can work skillfully in the airless vacuum.

I should like to end my dissertation with Schiller's words from the poem, "The Song of the Bell": The work shall praise the master, but the blessing comes from on high (Soll das Werk der Meister loben, doch der Segen kommt von oben).

After my sincere congratulations on the results of the space flights until now on the part of the courageous American astronauts, I wish you still many many successes in your space research, with the blessing of the good Lord. Like children who during the beautiful fall days admire the high-flying paper kites, so we humans of every nationality and of every color admire your high-flying rockets and are concerned about the health of the space pioneers of different nationalities who through the disclosure of the secrets of the illimitable space can open a new way to happiness for all God's children.

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